

The use of artificial habitat during surveys of small, terrestrial vertebrates at three sites in Victoria

Peter Homan

School of Life & Physical Sciences, RMIT University, GPO Box 2476V, Melbourne, Victoria 3001
Email: peter.homan@rmit.edu.au

Abstract

Artificial refuges can be used to determine the presence of terrestrial fauna and to replace or enhance lost or degraded natural habitat. Concrete pavers, roof tiles, sheets of galvanised iron and old fence posts were used at three sites in southern and western Victoria to determine the presence of small terrestrial vertebrates and to provide artificial habitat. Twenty species were recorded comprising two mammals, 12 reptiles and six amphibians. Fat-tailed Dunnart *Sminthopsis crassicaudata* was recorded on eight occasions using roof tiles in a lightly grazed, grassland site on the Victorian Volcanic Plain. Growling Grass Frog *Litoria raniformis* was found under old fence posts beside a restored wetland. Little Whip Snake *Parasuta flagellum* was recorded under artificial refuges from areas with thick grass or tussock cover. Spotted Marsh Frog *Limnodynastes tasmaniensis* was found in large numbers under all forms of artificial habitat. Concrete pavers and old fence posts returned the highest diversity of species and the greatest number of individuals. The usefulness of artificial terrestrial habitat as a survey method is compared with other survey methods. The value of artificial habitat as a management tool and associated problems are discussed. (*The Victorian Naturalist* 129 (4) 2012, 128–137)

Keywords: artificial habitat, Fat-tailed Dunnart, Growling Grass Frog, Little Whip Snake, skinks, frogs

Introduction

Natural terrestrial structures, such as surface rocks and fallen logs, provide important habitat for a wide range of vertebrate and invertebrate fauna (Menkhorst 1995; Cogger 2000; Ballinger and Yen 2002; Banks and Bennett 2003; Wilson and Swan 2010; Lindenmayer *et al.* 2011). However, in many parts of south-eastern Australia, such habitat has been removed or severely degraded. Mac Nally *et al.* (2002) estimated that levels of fallen wood on the southern Murray-Darling Basin may be approximately 15% of pre-European settlement levels. In Victoria, the loss of coarse woody debris from forests and woodlands is listed as a potentially threatening process under the *Flora and Fauna Guarantee Act 1988* (DSE 2009). In many districts, on both private and crown land, fallen limbs and logs have been harvested for firewood. In New South Wales, firewood cutting is listed as a key threatening process in temperate woodlands under the *Threatened Species Conservation Act 1995*. During control burning exercises designed to reduce natural fuel loads in forests and woodlands, fallen logs have often been split and allowed to burn.

During the early days of European settlement surface rock was commonly used in many districts to construct dry stone fences and other

structures. In recent times rocks have been harvested from the Victorian Volcanic Plain to be used in landscaping of suburban gardens. In south-east New South Wales removal of sandstone boulders for construction of bush gardens has been a major threatening process to rare fauna (Shine 1991). Shine *et al.* (1998) identified several species of herpetofauna that are likely to be at risk from removal of bush rocks. Similar habitat degradation has occurred in other parts of the world. In the western United States of America, illegal wildlife collecting has resulted in severe and widespread damage to reptile habitat in desert rocky outcrops (Goode *et al.* 2005). At sites where natural terrestrial habitat has been altered or destroyed, a range of artificial materials can be used as a survey method to determine the presence of small vertebrates and as a management tool to replace or enhance degraded environments. This paper examines the use of four types of artificial terrestrial material, as survey methods and in habitat enhancement programs, during long-term studies at three sites in southern and western Victoria. The artificial material comprised standard roof tiles, pieces of galvanised iron, old fence posts and four types of concrete pavers.

Study sites

Challicum is a 1300 ha sheep grazing property approximately 170 km west of Melbourne on the Victorian Volcanic Plain (37° 24'S, 143° 08'E). The land owner joined Land for Wildlife, the Victorian Government's voluntary conservation scheme, in 1990. Since then, various conservation works have been undertaken including fencing-off native grasslands and woodland areas, revegetation works and restoration of an ephemeral wetland (Homan 2011). A long-term study of the vertebrate fauna of the property commenced in December 2002 (Homan 2004). The survey sites at Challicum were located in the Ecological Vegetation Class (EVC) Plains Grassy Woodland.

Quarry Hills Bushland Park (QHBP) is situated in the suburb of South Morang approximately 22 km north-north-east of the Melbourne CBD. The park comprises two elevated sections: a western section known as Quarry Hill (EVC: Grassy Dry Forest, degraded) (37° 37'S, 145° 03'E) and an eastern section known as Granite Hills (EVC: Granitic Hills Woodland, degraded) (37° 37'S, 145° 05'E). The two sections are separated by an extensive housing estate. Major conservation works have been undertaken including weed removal, revegetation, rabbit control and a habitat enhancement program.

The Growling Frog Golf Course (GFGC) is located in Yan Yean, approximately 33 km north-north-east of the Melbourne CBD (37° 33'S, 145° 04'E). The golf course was developed under strict environmental guidelines that required the protection of native vegetation and important habitat. Major conservation works have been undertaken including construction of permanent wetlands for the Growling Grass Frog *Litoria raniformis*, rabbit control, weed removal, revegetation and a habitat enhancement program. The EVC for survey sites at GFGC was Plains Grassy Woodland, degraded.

QHBP and GFGC are both managed by the City of Whittlesea. Surveys to assess conservation works and to determine the presence and relative abundance of vertebrate fauna have been conducted at both reserves since 2006 and 2007 respectively (Homan unpubl.data).

Methods

Challicum

Standard roof tiles (410 x 245 mm), old fence posts (1200–1500 x 180–230 mm) and galvanised iron (Average: 600 x 600 mm) were used in several parts of this property (Table 1). Survey sites included areas of fenced-off Plains Grassy Woodland, ephemeral wetlands and areas with native grasses, fallen logs, surface rocks and cracking, unploughed soils. A 64 ha paddock with large expanses of native grasses, several ephemeral wetlands and some fallen logs and stumps was chosen as a principal survey site. This paddock had never been ploughed and was only lightly grazed. It also contained many mature River Red Gums *Eucalyptus camaldulensis*. Four grids of 25 roof tiles per grid were laid between December 2003 and June 2004. One grid was in a section of the paddock with a thick cover of Wallaby Grass *Austrodanthonia* sp. and Spear Grass *Austrostipa* sp., near an ephemeral wetland. Six old fence posts and five pieces of galvanised iron were alternated 10 m apart around this wetland. Three other tile grids, 50 m apart, were established in open sections of this paddock in areas of sparse cover of Wallaby Grass with some introduced pasture. Each tile grid contained five lines, with five tiles on each line. Lines and tiles were spaced at 5 m within each grid.

In August 2005, another grid of 25 roof tiles (configuration as above) was established in a recently fenced-off area of Plains Grassy Woodland in another part of this property. At the same time 14 old fence posts and 22 pieces of galvanised iron were placed alternately in a line in this area. Posts and galvanised iron were 10 m apart. In May 2006, 43 old fence posts (Fig. 1) were placed 10 m apart around the edges of two ephemeral wetlands in other parts of the property. Artificial habitat at Challicum was monitored on 19 occasions, once every three months between June 2004 and November 2007 and once in November 2009, November 2010, April 2011 and September 2011. Each type of habitat was checked early in the morning on each occasion, usually within two hours of day-break.

Artificial habitat used at QHBP and GFGC was sourced opportunistically as various items

Table 1. Number of each type of artificial habitat used at Challicum, Quarry Hills Bushland Park (QHBP) and Growling Frog Golf Course (GFGC).

	Roof Tile	Galvanised Iron	Fence Post	Concrete Paver
Challicum	125	27	63	
QHBP	50	35		100
GFGC		22		68

became available during demolition of several local properties. As a consequence galvanised iron used at these two sites was a different size from that used at Challicum. Rather than send this material to landfill it was decided to use these items as part of habitat enhancement programs at these two sites.

Quarry Hills Bushland Park

Standard roof tiles, galvanised iron (Average: 800 x 800 mm) and concrete pavers (380 x 380 x 45 mm) were used at this site (Table 1). In March 2006, five lines of roof tiles, with 10 tiles



Fig. 1. Old fence posts beside restored ephemeral wetland at Challicum. Photo by Peter Homan.

spaced every 10 m on each line, were established in grassland areas in the western section of this reserve. The sites contained Weeping Grass *Microlaena stipoides*, some Spear Grass *Austrostipa* sp., small areas of *Lomandra* sp and introduced grasses. Lines of tiles were approximately 100 m apart. At the same time, in the woodland area on the eastern side of the reserve, five lines of concrete pavers (Fig. 2) with 10 pavers 10 m apart on each line, were established. Lines were approximately 50 m apart and a nesting chamber with an entrance hole was excavated under each paver. Also at this time one line of 35 pieces of galvanised iron 10 m apart was established in this area. By December 2006, many roof tiles had sustained damage and disturbance, therefore two lines were replaced with concrete pavers. In March 2009, the remaining 30 roof tiles were replaced with concrete pavers. Because of human interference the line of galvanised iron was removed in February 2008. Artificial habitat at QHBP was monitored on 10 occasions, once every six months between September 2006 and May 2011.

Growling Frog Golf Course

Galvanised iron (Average: 800 x 800 mm) and concrete pavers of three shapes and sizes (600 x 600 x 50 mm; 600 x 135 x 50 mm; 880 x 165 x 50 mm) were used at this property (Table 1). In March 2008, 22 concrete pavers and 22 pieces of galvanised iron were laid alternately 10 m apart in a line amongst introduced grasses in degraded Plains Grassy Woodland on the eastern side of this property. At the same time an additional 16 pavers were laid 10 m apart in a line adjacent to a dry stone fence on the western boundary of the property. In February 2010, an additional 30 concrete pavers were laid 10 m apart in a line on the eastern side, south of the original line mentioned above. A nesting chamber with an entrance hole was excavated under each paver.



Fig. 2. Concrete paver at Quarry Hills Bushland Park. Photo by Peter Homan.

Artificial habitat at GFGC was monitored on six occasions, once every six months between September 2008 and May 2011.

Results

Twenty vertebrate species were recorded using artificial terrestrial habitat (Table 2). These included two mammals: the Fat-tailed Dunnart *Sminthopsis crassicaudata* (Fig. 3) was recorded beneath roof tiles on eight occasions and a fence post on one occasion at Chalicum; the introduced House Mouse *Mus musculus* was found under roof tiles, fence posts and galvanised iron at Chalicum. This species was also found under concrete pavers, galvanised iron and a roof tile at GFGC and QHBP.

Twelve species of reptiles, comprising eight skinks and four elapid snakes, were recorded (Table 2). Southern Grass Skink *Pseudemoia entrecasteauxii*, Tussock Skink *Pseudemoia pagenstecheri* and Blotched Blue-tongued Lizard *Tiliqua nigrolutea* were recorded under galvanised iron at Chalicum. Common Blue-tongued Lizard *Tiliqua scincoides* (Front cover) was found under all forms of artificial refuges at Chalicum. The Tussock Skink was also found under roof tiles and an old fence post at this site. Eastern Three-lined Skink *Acritoscincus duperreyi*, Large Striped Skink *Ctenotus robustus* (Fig. 4), Garden Skink *Lampropholis guichenoti*, Bougainville's Skink *Lerista bougainvillii* and Common Blue-tongued Lizard were all recorded at QHBP. At GFGC, Tussock Skink, Bougainville's Skink, Large Striped Skink and Common Blue-tongued Lizard were recorded. A Tiger Snake *Notechis scutatus* was recorded under an old



Fig. 3. Fat-tailed Dunnart *Sminthopsis crassicaudata*. Photo by Maryrose Morgan.



Fig. 4. Large Striped Skink *Ctenotus robustus*. Photo by Tim Connell.

fence post beside an ephemeral wetland and under galvanised iron in grassland at Chalicum. One sub-adult Eastern Brown Snake *Pseudonaja textilis* was recorded under a roof tile on this property. An Eastern Brown Snake was recorded under a large paver at the GFGC. Lowland Copperhead *Austrelaps superbus* was recorded under pavers and galvanised iron at QHBP and under pavers at GFGC. Little Whip Snake *Parasuta flagellum* (Fig. 5) was recorded under all forms of artificial habitat at all three study sites.

Six species of amphibians, comprising two hylid frogs and four myobatrachid frogs, were recorded (Table 2). The majority of records of amphibians at Chalicum were from refuges placed near ephemeral wetlands. Growling Grass Frog *Litoria raniformis* (Fig. 6) was found on two occasions under old fence posts beside a restored ephemeral wetland on this property.

Table 2. List of vertebrate species and numbers recorded using artificial habitat at Challicum, Quarry Hills Bushland Park (QHBP) and Growling Frog Golf Course (GFGC). RT = Roof Tile; GI = Galvanised Iron; FP = Fence Post; CP = Concrete Paver. * indicates introduced species.

Species	Challicum			QHBP			GFGC	
	RT	GI	FP	RT	GI	CP	GI	CP
Fat-tailed Dunnart <i>Sminthopsis crassicaudata</i>	8		1					
House Mouse <i>Mus musculus</i> *	3	15	10	1		3	1	6
Eastern Three-lined Skink <i>Acritoscincus duperreyi</i>					4	1		
Large Striped Skink <i>Ctenotus robustus</i>						4		1
Garden Skink <i>Lampropholis guichenoti</i>				1	1			
Bougainville's Skink <i>Lerista bougainvillii</i>						2	1	5
Southern Grass Skink <i>Pseudemoia entrecasteauxii</i>		7						
Tussock Skink <i>Pseudemoia pagenstecheri</i>			5				4	
Blotched Blue-tongued Lizard <i>Tiliqua nigrolutea</i>		1						
Common Blue-tongued Lizard <i>Tiliqua scincoides</i>	2	3	1	5	4	26	3	2
Lowland Copperhead <i>Austrelaps superbus</i>					1	2		4
Tiger Snake <i>Notechis scutatus</i>		1	1					
Little Whip Snake <i>Parasuta flagellum</i>	15	8	7	1	1	13	1	1
Eastern Brown Snake <i>Pseudonaja textilis</i>	1							1
Growling Grass Frog <i>Litoria raniformis</i>			2					
Southern Brown Tree Frog <i>Litoria ewingii</i>	1	1	16					
Plains Froglet <i>Crinia paransignifera</i>			1					
Common Froglet <i>Crinia signifera</i>	1		11			2		
Southern Bullfrog <i>Limnodynastes dumerilii</i>						12	1	
Spotted Marsh Frog <i>Limnodynastes tasmaniensis</i>	65	24	27	3		33	12	71

Significant numbers of Southern Brown Tree Frog *Litoria ewingii*, Common Froglet *Crinia signifera* and Spotted Marsh Frog *Limnodynastes tasmaniensis* were found under fence posts beside ephemeral wetlands at Challicum. One Plains Froglet *Crinia paransignifera* was found under a fence post beside an ephemeral wetland on this property. Common Froglet and Spotted Marsh Frog were also located under roof tiles in grassland areas at Challicum. Spotted Marsh Frog was located in significant numbers under all forms of artificial habitat at QHBP and GFGC. Many Southern Bullfrogs *Limnodynastes dumerilii* were found under concrete pavers at QHBP.

Discussion

Fat-tailed Dunnart

The Fat-tailed Dunnart is nocturnal and uses natural structures such as rocks and fallen logs for nesting sites and shelter during the day (Menkhorst 1995). The species also shelters under artificial refuges and has been recorded in western Victoria under discarded fence posts and abandoned farm implements (Bennett 1982).

Fat-tailed Dunnarts were recorded at Challicum only under roof tiles from grids established in areas with sparse ground cover. The only other survey method used in the vicinity of these grids was systematic searching under fallen logs and old stumps, which resulted in the capture of one specimen. One other Fat-tailed Dunnart was found under an old fence post positioned beside a restored wetland surrounded by a large expanse of heavily grazed introduced pasture. No Fat-tailed Dunnarts or evidence of the species (scats) were found under artificial habitat of any sort in areas with thick ground cover. Two pitfall lines were established at Challicum, but both were in areas with thick tussock cover, and neither recorded Fat-tailed Dunnart. Morton (1978), Read (1984), Hadden (2002) and Parker (2009) also found that Fat-tailed Dunnart preferred areas with sparse ground cover.

Live-trapping, using wire cage traps of various designs, and Elliott traps (Elliott Scientific Equipment, Upwey, Victoria), has been used extensively to survey terrestrial mammals in Victoria, including small dasyurid marsupi-



Fig. 5. Little Whip Snake *Parasuta flagellum*. Photo by Peter Homan.



Fig. 6. Growling Grass Frog *Litoria raniformis*. Photo by Maryrose Morgan.

als (Suckling and Heislars 1978; Menkhorst and Beardsell 1982; Conole and Baverstock 1983; Laidlaw and Wilson 1989; Bennett 1990; Homan 2009). However, these methods have not been successful during surveys for Fat-tailed Dunnart. Morton (1978) failed to trap Fat-tailed Dunnart at three sites in western Victoria and outback New South Wales using these traps, despite the fact that the species was known to occur at each of the study sites at the time of trapping.

Various investigators have tried a variety of traps, but the only methods that have been successful in capturing Fat-tailed Dunnarts have been pitfall traps, active searching and the use of artificial shelters — cage and Elliott traps have not been successful (Menkhorst and Beardsell 1982; Read 1984; Hadden 2002; Cleemann *et al.* 2005). Morton (1978) and Parker (2009) have also detected this species while spotlighting. Morton (1978) employed systematic searching under surface rocks at Werribee,

Victoria, as his main survey method, resulting in numerous records of Fat-tailed Dunnart. Whilst rock turning is an effective method to detect this species, this technique has resulted in animals being accidentally crushed (Morton 1978).

Other investigators have detected *Sminthopsis* spp. using artificial refuges (Beardsell 1997; Michael *et al.* 2003; Michael *et al.* 2004; Homan 2006; Homan and Schultz 2012; FNCV unpubl. data; G Peterson unpubl. data; P Robertson unpubl. data; D De Angelis unpubl. data). At Chalicum, the first record of Fat-tailed Dunnart using a roof tile was obtained in November 2004, five months after the grid was established. Michael *et al.* (2004) suggested that Fat-tailed Dunnart can disperse rapidly and therefore has the ability to quickly colonise artificial refuges. Whilst the number of records from Chalicum is fairly small, they provide further evidence that roof tiles and other artificial refuges can provide an efficient and relatively non-intrusive method to survey for the presence of Fat-tailed Dunnart.

Herpetofauna

The Growling Grass Frog is a large, terrestrial hyloid frog that historically occurred over a wide area of south-eastern Australia (Cogger 2000; Tyler and Knight 2009). The species was once common throughout much of Victoria; however, in recent times the Growling Grass Frog has disappeared from many parts of its former range (Cleemann and Gillespie 2007). Consequently the species is listed as vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 and is listed as threatened under the Victorian *Flora and Fauna Guarantee Act* 1988 (DSE 2010). In Victoria, the species is also recognised as vulnerable by the Department of Sustainability and Environment (DSE 2007).

During times of inactivity the Growling Grass Frog shelters in thick vegetation, in cracks in the ground or under refuges such as rocks and logs (Pyke 2002). During the present study two Growling Grass Frogs were found under old fence posts laid beside a restored ephemeral wetland on the floodplain of Fiery Creek. The first specimen was found in mid-April 2011 and the second in mid-September 2011, five

years after the fence posts had been laid at this wetland. Fiery Creek, which flows year round, is situated 150 m to the south of the restored wetland and is likely to be the source of Growling Grass Frogs at this site.

Survey methods for adult Growling Grass Frog include listening for calling males both day and night, active searching at wetlands during the day and detecting adults at night by spotlighting (Heard *et al.* 2006). At Chalicum, the species was detected on three other occasions using these methods: adult males were heard calling during the night on two occasions and one adult was seen beside a wetland during the day. The use of artificial refuges offers an additional survey method for Growling Grass Frogs, especially during times of inactivity and at sites where no rocks or natural logs are present.

The Little Whip Snake is a small, nocturnal elapid snake which shelters during the day under rocks or logs, or in cracks in the soil (Cogger 2000; Wilson and Swan 2010). The species is found in woodlands and dry sclerophyll forests and is common in many grassland areas on the Victorian Volcanic Plain (Victorian Biodiversity Atlas). At Chalicum, the majority of Little Whip Snake records were from roof tiles, with smaller numbers from galvanised iron and old fence posts. All records were confined to sites with light grazing or no grazing, thick tussock cover and cracking soils. Six were from a site that had been ploughed once many decades previously, whilst 24 were from the unploughed paddock mentioned above. No specimens were found under roof tiles in the three grids established in the area with sparse cover, despite this site having never been ploughed and containing cracking soils. Two other survey methods produced records of Little Whip Snakes at Chalicum: pitfall trapping (one capture from 245 pit-nights) and active searching (three specimens found under logs).

Little Whip Snakes have been found at other sites on Victoria's Volcanic Plain with light grazing and substantial grass cover (G Turner pers. comm., 24 February 2007). The species has also been recorded using roof tiles in other parts of the Victorian Volcanic Plain (G Peterson unpubl. data). At QHBP and GFGC Little Whip Snakes readily occupied concrete pavers, with

individuals found under a roof tile and galvanised iron. Moderate to thick grass cover and loose surface rock were features of these sites. At these two properties, Little Whip Snakes were recorded by two other survey methods: funnel trapping (one capture from 536 funnel trap-nights at GFGC and one capture from 645 funnel trap-nights at QHBP) and active searching (eight under rocks at GFGC; 10 under rocks and two under logs at QHBP).

Concrete pavers and old fence posts produced the best overall results for herpetofauna, which may in part be due to their insulation properties. Nevertheless, many variables affect data obtained from the use of artificial habitat. Artificial refuges placed on an undulating substrate will produce depressions and cavities that may be attractive to numerous species. Conversely, a large concrete paver placed completely flat on a hard substrate is unlikely to be suitable habitat for most species. However, if a nesting chamber with entrance holes is constructed, this habitat may be used by a range of fauna. Pavers placed on sandy or loose soil may be used by burrowing species such as Bougainville's Skink or Southern Bullfrog. Whilst roof tiles suit small skinks, small frogs and small snakes, like the Little Whip Snake, they are sometimes unsuitable for larger specimens of species such as the Common Blue-tongued Lizard. All specimens of this species found under roof tiles during these studies were juvenile. The condition of old fence posts also affects results. Michael *et al.* (2004) found that several species preferred large, partially decaying posts with many holes. At Chalicum, two Little Whip Snakes were found inside cracks in the bottom of older fence posts.

A range of survey methods was used to determine the presence of herpetofauna at each study site. Of the nine reptile and seven amphibian species recorded at the Chalicum study sites, using pitfall trapping, funnel trapping, listening, active searching and artificial habitat, seven reptile and five amphibian species were recorded by the use of artificial refuges. Two species, Eastern Brown Snake and Blotched Blue-tongued Lizard, were recorded solely by the use of artificial habitat. Of the 12 reptile and seven amphibian species recorded at QHBP and GFGC, using funnel trapping, listening, active searching and artificial habi-

tat, nine reptile and three amphibian species were recorded by the use of artificial habitat. At QHBP and GFGC, no species were recorded solely by the use of artificial refuges.

Other herpetofauna studies have involved the use of artificial refuges as a survey method, including roof tiles (Clemann and Nelson 2005; O'Shea 2005), concrete pavers (Webb and Shine 2000), galvanised iron (Heinze 1997; Homan 2003) and old fence posts (Michael *et al.* 2003). In western Victoria an extensive study using roof tiles recorded 25 reptile species and seven amphibian species (G Peterson unpubl.data).

Pitfall trapping with drift fence is commonly used to survey small to medium reptiles and terrestrial frogs (Menkhorst 1982; Hadden and Westbrooke 1996; MacNally and Brown 2001; Clemann *et al.* 2005; Thompson *et al.* 2005). However, establishing pitfall lines is labour-intensive and can be extremely difficult in rocky areas or at sites with heavy soils. Digging of pitfall lines in some locations can also cause substantial disturbance to soils and vegetation (pers.obs). Funnel traps have been suggested as an alternative survey method (Thompson and Thompson 2007); however, establishing drift fences for funnel trap lines can also be difficult in rocky areas (pers.obs). The results presented by Brown and Nicholls (1993) suggest that a combination of survey techniques will return the most complete record of reptiles in an area and Mac Nally and Brown (2001) suggest that biodiversity surveys for reptiles may require substantial effort to provide a reasonable representation of the reptile species present in some areas.

Herpetologists have long known that various items of human refuse provide habitat for many reptiles and amphibians (Tyler 2000; Brown *et al.* 2008; Homan 2009; Hoser 2009; Turner 2010). Artificial terrestrial habitat presents an alternative or supplementary method for surveying many species of herpetofauna. Once artificial material is placed on site, checking is relatively easy and safe and poses little risk to specimens sheltering beneath refuges.

Artificial terrestrial habitat as a management tool

Habitat loss, fragmentation and degradation are major causes of decline in populations

of vertebrate fauna (Shine 1991; Shine *et al.* 1998; Ford *et al.* 2001; Mac Nally and Brown 2001; Brown *et al.* 2008; Mac Nally *et al.* 2009). Menkhorst (1995) expressed concern for the survival of Fat-tailed Dunnart populations on private land as modern, intensive farming practices cause the loss of shelter and nesting sites. Several studies have highlighted the value of natural terrestrial structures (Halliger 1993; Mac Nally *et al.* 2001; Wallis *et al.* 2007; Alsfeld *et al.* 2009; Heard *et al.* 2010). Revegetation and habitat rehabilitation programs, however, often fail to include, or do not give sufficient importance to the provision of, terrestrial structures such as rocks and logs or artificial alternatives (Buchanan 2009).

In areas where natural refuges have been removed or destroyed, various forms of artificial materials can be used as replacement habitat for some species. In degraded areas devoid of natural terrestrial habitat, the addition of artificial refuges may be beneficial, especially until natural loads accumulate, which may take considerable time (Manning *et al.* 2007).

Various authors have recommended the application of artificial refugia in degraded environments (Goldingay and Newell 2000; Webb and Shine 2000; Lindenmayer *et al.* 2003; Michael *et al.* 2004; Alsfeld *et al.* 2009). Lindenmayer *et al.* (2011) stated that there can be considerable ecological values in adding old fence posts to revegetation areas. Habitat enhancement programs can sometimes be at risk from disturbance from humans (Goldingay and Newell 2000; Webb and Shine 2000). However, Croak *et al.* (2008) demonstrated that colouring artificial refuges, so that they were inconspicuous, was a useful technique to reduce the risk of disturbance.

At Quarry Hills Bushland Park, where a large housing estate borders the reserve, human disturbance was a major management problem. After roof tiles were laid in 2006, many soon became cracked or broken, which may have been due at least partly to human interference. Because of this concrete pavers were introduced as replacements. However, the pavers were unpainted and therefore fairly conspicuous, and when checked in December 2009, 40 were found turned over and not replaced in their

original positions. Challicum and the Growling Frog Golf Course were a considerable distance from towns and housing areas and no human disturbance occurred at these two sites.

Whilst artificial terrestrial refuges can provide important habitat for a wide range of small vertebrates, land managers need to consider several management strategies to ensure that refuges do not suffer from human interference. A combination of camouflaging refuges, fencing or screening with suitable indigenous plants may be necessary to ensure that habitat restoration programs using artificial material are successful.

Acknowledgements

Field activities at the three study sites were conducted under the terms of research permit numbers 10002377, 10004149 and 10005276 issued by the Department of Sustainability and Environment and Approval no 02/07 and 25/09 of the Wildlife and Small Institutions Animal Ethics Committee of the Department of Primary Industries. Maryrose Morgan of Carlton provided field assistance. Staff and students from the School of Life and Physical Sciences, RMIT University, assisted with monitoring of refuges at GFGC and QHBP. Tim Connell of the City of Whittlesea provided advice and guidance during field activities at GFGC and QHBP. Mr Doug Hopkins of Challicum kindly provided unlimited access to his wonderful property. Many thanks to Gary Peterson, Grant Turner and David De Angelis for providing unpublished data. Special thanks to Peter Robertson of Wildlife Profiles Pty Ltd who introduced me to the use of roof tiles for herpetofauna surveys. An anonymous referee suggested changes that improved the manuscript.

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Received 11 August 2011; accepted 29 March 2012